CLAIMS:

1. A method for semiconductor wafer fabrication, the method comprising:

placing a layer of a liquid solvent on a surface of a wafer; and

transporting a reactant gas that is inert in the liquid solvent and that is capable of reacting with a material on the surface of the wafer through the layer of liquid solvent to the surface of the wafer.

2. The method of claim 1, wherein the solvent is selected from the group consisting essentially of water, perfluorocarbons, and mixtures thereof.

3. The method of claim 1, wherein the reactant gas is ozone.

4. The method of claim 1, wherein the layer of liquid solvent is continuous over the wafer surface and has a thickness of from about 1 micron to about 3000 microns.

5. The method of claim 1, wherein the layer of liquid solvent has a thickness of less than about 100 microns.

6. A method for semiconductor wafer fabrication, the method comprising:

incorporating a reactant gas that is capable of reacting with a material on the surface of a wafer into a liquid solvent that is inert to the material on the surface of the wafer to provide a reactant mixture; and

forming a film of the reactant mixture on the surface of the wafer so that the reactant gas is transported through the film of reactant mixture to the surface of the wafer and reacts with the material thereon.

7. The method of claim 6, wherein the reactant gas is inert in the liquid solvent.

8. The method of claim 6, wherein the thin film of the reactant mixture has a thickness of from about 1 micron to about 100 microns.

9. The method of claim 6, including flowing the reactant gas over the thin film of the reactant mixture such that some of the flowing reactant gas is transported through the film to the surface of the wafer.

10. The method of claim 6, including cooling the wafer to a temperature equal to about a dew point of the liquid solvent.

11. A method for removing a material from a surface of a semiconductor wafer, the method comprising:

selecting a reactant gas capable of reacting with a material on a wafer surface;

condensing a liquid solvent onto a surface of the wafer from which material is to be removed, the liquid solvent being inert to the material on the wafer surface; and

exposing the condensed liquid solvent to the reactant gas, the reactant gas being inert to the solvent and reacting with the material on the wafer surface to remove such material.

12. The method of claim 11, including incorporating reactant gas into the liquid solvent to form a liquid solvent that comprises a reactant mixture that contains reactant gas, and wherein the step of condensing the liquid solvent comprises condensing the reactant mixture on a surface of the wafer such that the reactant gas reacts with and removes the material on the wafer surface.

13. The method of claim 11, including removing the reactant mixture from the wafer surface.

14. A method for semiconductor wafer fabrication, the method comprising:

vaporizing a liquid solvent that is inert to a material on a surface of a wafer;

selecting a reactant gas that is capable of chemically reacting with the material on the surface of the wafer;

incorporating the reactant gas into the vaporized liquid solvent; and

condensing the vaporized solvent incorporating the reactant gas to form a film on the surface of the wafer so that the reactant gas is transported through the film to the material on the surface of the wafer.

15. The method of claim 14, including flowing the reactant gas over the film such that some of the flowing reactant gas is transported through the film to the surface of the wafer.

16. A method for semiconductor wafer fabrication, the method comprising:

selecting a liquid solvent that is inert to a material on a surface of a wafer;

forming a mist of liquid solvent droplets above the surface of the wafer;

selecting a reactant gas that is capable of chemically reacting with the material on the surface of the wafer and exposing the reactant gas to the liquid solvent droplets; and

forming, on the surface of the wafer, a thin film of the liquid solvent and exposing the thin film to the reactant gas so that the reactant gas is transported through the thin film to the material on the surface of the wafer.

17. The method of claim 16, including cooling the wafer to a temperature equal to about a dew point of the liquid solvent.

18. The method of claim 16, wherein only one reactant gas is used.

19. The method of claim 16, wherein the thin film has a thickness of from about 1 micron to about 100 microns.

20. A method for cleaning a semiconductor wafer, the method comprising:

placing a liquid layer onto a surface of a wafer;

flowing a wafer cleaning gas over the liquid layer such that some of the flowing gas is transported through the liquid to the surface of the wafer; and

reacting the wafer cleaning gas transported through the liquid layer to the surface of the wafer with material on the wafer surface to clean the wafer.

21. The method of claim 20, wherein the liquid is a solvent for the cleaning gas.

22. The method of claim 20, wherein the liquid layer is a thin film on the wafer surface.

23. The method of claim 20, wherein the liquid is selected from the group consisting essentially of water, perfluorocarbons, and mixtures thereof.

24. The method of claim 20, wherein the cleaning gas is ozone.

25. The method of claim 20, wherein the liquid solvent is inert to the material on the surface of the wafer.

26. A method of semiconductor fabrication, the method comprising:

selecting a liquid solvent that is inert to a material on a surface of a wafer;

selecting a reactant gas that is capable of chemically reacting with the material on the surface of the wafer and incorporating the reactant gas into the liquid solvent; and

showering the liquid solvent incorporating the reactant gas onto the surface of the wafer and exposing the liquid solvent to the reactant gas so that the reactant gas chemically reacts with the material on the surface of the wafer.

27. A method according to claim 26, wherein the exposing step comprises exposing a film of the liquid solvent to the reactant gas while the film is on the wafer surface.

28. The method of claim 26, wherein the wafer is at a temperature equal to about 25 °C and the liquid solvent is at a temperature equal to about 90 °C.

29. The method of claim 26, wherein the wafer is supported in a vertical position relative to the shower of liquid solvent.

30. A method for semiconductor wafer fabrication, the method comprising:

selecting a reactant gas capable of reacting with a material on a wafer surface;

incorporating the reactant gas in a liquid solvent to form a reactant mixture;

forming a mist of reactant mixture droplets;

forming, on the surface of the wafer, a thin film of the reactant mixture so that the reactant gas is transported through the thin film to the material on the surface of the wafer.

31. A method for semiconductor wafer fabrication, the method comprising:

selecting a reactant gas capable of reacting with a material on a wafer surface;

incorporating the reactant gas in a liquid solvent that is inert to the material on the wafer surface;

forming a thin layer of the liquid solvent incorporating the reactant gas, on the wafer surface;

contacting the thin layer of liquid solvent with an atmosphere of the reactant gas; and

reacting the reactant gas with the material on the wafer surface to remove the material from the wafer surface.

32. A method for removing photoresist material from a semiconductor wafer, the method comprising:

selecting a liquid that does not chemically react with photoresist material;

forming a thin layer of the liquid on a surface of a wafer having photoresist material thereon;

introducing ozone gas over the layer of liquid such that some of the flowing ozone gas is transported through the thin layer of liquid solvent to the surface of the wafer; and

reacting the ozone gas transported to the surface of the wafer with the photoresist material on the wafer surface.

33. The method of claim 32, wherein the ozone gas is introduced prior to the formation of the layer of liquid.

34. The method of claim 32, wherein the ozone gas is introduced simultaneously with the formation of the layer of liquid.

35. The method of claim 32, wherein the ozone gas is introduced after the formation of the liquid layer.

36. The method of claim 32 in which the liquid layer is less than about 100 microns thick over the majority of the wafer surface containing the liquid layer.

37. A method for removing photoresist material from the surface of the wafer, the method comprising:

vaporizing a mixture of water and ozone gas;

condensing a thin layer of the mixture on a wafer surface having photoresist material thereon; and

reacting the ozone gas in the mixture with the photoresist material on the wafer surface to remove the photoresist material therefrom.

38. A method for removing photoresist material from the surface of the wafer, the method comprising:

forming a mist of droplets of a mixture of water and ozone gas;

forming a thin layer of the mixture on a wafer surface having photoresist material thereon; and

flowing ozone gas over the thin layer such that some of the flowing ozone gas is transported through the thin layer to the surface of the wafer; and

reacting the ozone gas in the thin layer with the photoresist material on the wafer surface to remove the photoresist material therefrom.

39. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to apply a solvent to at least one of the first and second side surfaces of the wafer positioned within the chamber so as to form a film of liquid solvent on said at least one of the first and second wafer side surfaces;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium which carries at least some of the at least one reactive gas through the film to said at least one of the first and second wafer side surfaces where the at least one reactive gas chemically reacts with said at least one of the first and second wafer side surfaces.

40. An apparatus according to claim 39 including a gas incorporator adapted to introduce said at least one reactant gas into the solvent prior to forming the film of liquid solvent.

41. An apparatus according to claim 39 wherein said at least one reactant gas comprises ozone as a major component and the solvent comprises water as a major component.

42. An apparatus for delivering ozone gas to the surface of a wafer comprising:

a wafer receiving chamber;

a wafer carrier positioned within the chamber and carrying at least one wafer;

a liquid depositor adapted to form a layer of liquid on at least one major surface of a wafer supported by the wafer carrier within the chamber;

an ozone gas source coupled to the chamber so as to deliver ozone gas to the chamber and increase the concentration of ozone gas within the chamber;

the liquid layer transporting ozone gas to the surface of the wafer to thereby expose the wafer surface to ozone.

43. An apparatus according to claim 42 wherein the apparatus includes a temperature controller adapted to maintain the temperature of the wafer at the dew point of the liquid such that liquid from the liquid depositor is condensed onto the wafer to form the layer of liquid.

44. An apparatus for cleaning semi-conductor wafers comprising:

a chamber sized to receive at least one wafer to be cleaned;

a reactant gas source inlet and outlet, the inlet and outlet each communicating with the chamber and defining a gas flow path for reactant gas from the inlet to the outlet;

a reactant gas source coupled to the inlet such that reactant gas is delivered from the inlet and flows in the gas flow path to the outlet;

a wafer carrier positioned within the chamber and supporting at least one wafer at least partially in the gas flow path;

a liquid layer former coupled to the chamber and operable to form a layer of liquid on at least one major surface of a wafer supported within the chamber, the liquid being selected so as to be substantially non-chemically-reactive with the reactant gas, whereby the reactant gas is transported through the liquid layer to the wafer surface, the reactant gas being selected so as to

chemically react with components on the surface of the wafer to clean the wafer.

45. An apparatus according to claim 44 including a reactant gas incorporator adapted to introduce reactant gas into the liquid before the liquid layer is formed.

46. An apparatus for stripping photo-resist from semi-conductor wafers comprising:

a film former adapted to form a film of liquid solvent onto a surface of the wafer which is to be stripped of photo-resist;

a gas exposer adapted to expose the film of liquid solvent to a source of at least one reactant gas which is substantially non-chemically reactive with the solvent and which is chemically reactive with the photo-resist so as to the strip the photo-resist from the wafer surface; and

whereby reactant gas is transported through the film of liquid solvent to the wafer surface.